Anterior pituitary and prolactin hormone

INTENDED LEARNING OBJECTIVES (ILOs)

By the end of this lecture the student will be able to:

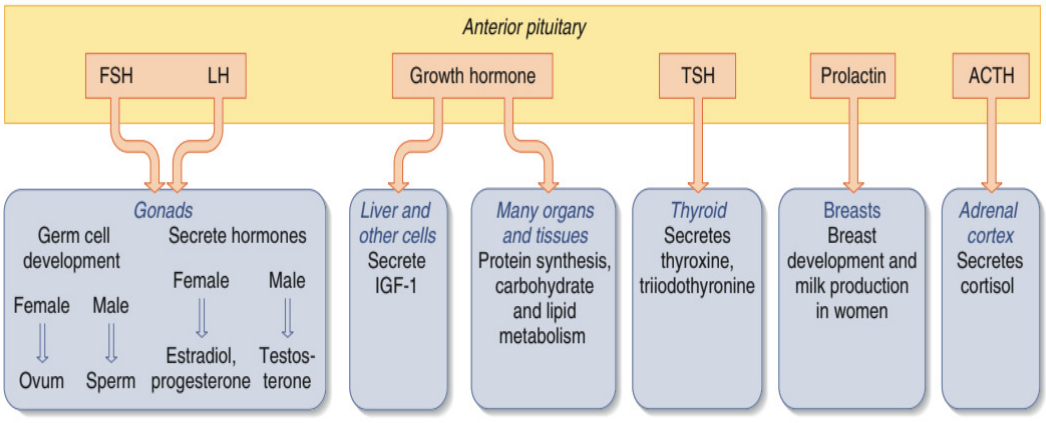
- ✓ List the anterior pituitary tropic and non-tropic hormones.
- ✓ Correlate the hypothalamic secretion to the anterior pituitary gland functions and secretions.
- ✓ Describe the feedback control of endocrine secretion.
- ✓ Describe the main effects of anterior pituitary hormones.
- ✓ Summarize the functions and regulation of Prolactin.

Anterior pituitary gland (Adenohypophysis)

Pituitary gland is a master gland; it orchestrates the functions of most of the body glands like thyroid gland, adrenal cortex, testes and ovary.

Some glands are **NOT** under control of anterior pituitary e.g. **Parathyroid gland**

It secrets 6 hormones



These hormones can be divided into:

- **Tropic Hormones** (regulate secretion of another specific endocrine gland) like Adrenocorticotropic hormone (ACTH), Thyroid-stimulating

hormone (TSH), Follicle-stimulating hormone (FSH) and luteinizing hormone (LH).

- **Non tropic Hormones** (does not stimulate secretion of another hormone) like growth hormone (GH) and prolactin (PRL).

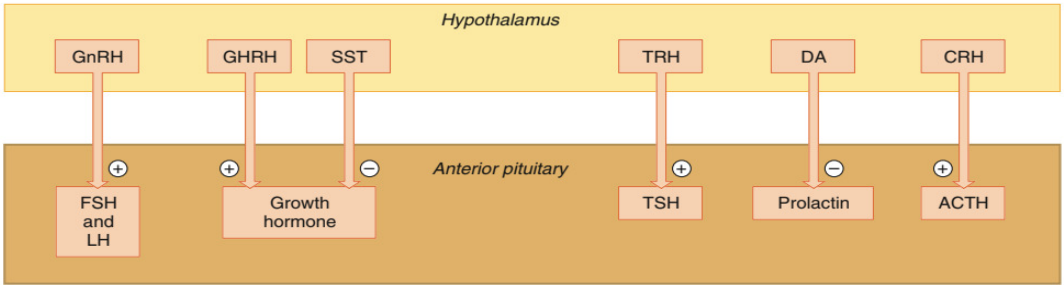
Control of anterior pituitary secretion

1- Hypothalamic control

Hypothalamus controls the anterior pituitary by secreting releasing hormones *(stimulates release of the anterior pituitary hormones)* and inhibiting or release inhibiting hormones *(inhibit release of the anterior pituitary hormones).*

The releasing hormones e.g. CRH, TRH, GRH and GnRH.

The inhibiting or release inhibiting hormones e.g. somatostatin (growth hormone inhibiting hormone) and Dopamine which is the (prolactin inhibiting hormone)



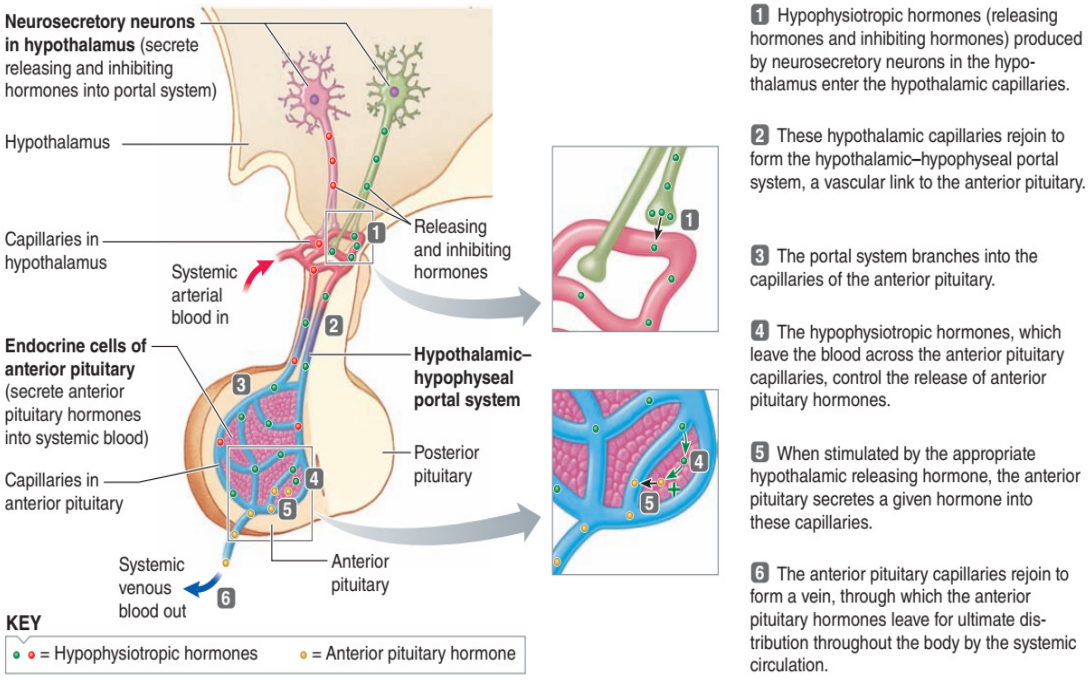
Major known hypophysiotropic hormones	Major effect on anterior pituitary
Corticotropin-releasing hormone (CRH)	Stimulates secretion of ACTH
Thyrotropin-releasing hormone (TRH)	Stimulates secretion of TSH
Growth hormone–releasing hormone (GHRH)	Stimulates secretion of GH
Somatostatin (SST)	Inhibits secretion of GH
Gonadotropin-releasing hormone (GnRH)	Stimulates secretion of LH and FSH
Dopamine (DA)*	Inhibits secretion of prolactin

These hormones reach the anterior pituitary through the ***Hypothalamic-hypophyseal portal circulation***

N.B:

All the anterior pituitary hormones are controlled by releasing hormones except Prolactin Which is under tonic inhibition by dopamine. So if the pituitary stock was severed, all the anterior pituitary hormones will decreased except prolactin due to its release from the tonic inhibition.

Hypothalamic- hypophyseal portal circulation

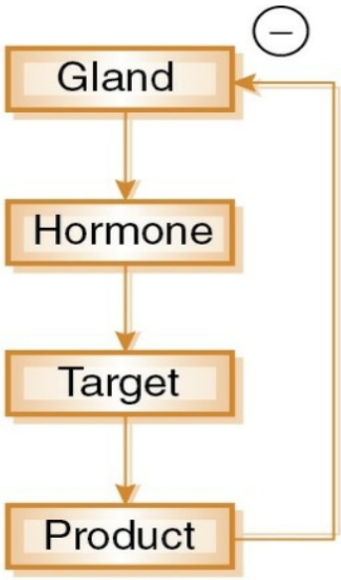


Importance of the portal circulation: ensuring reliable transmission of hypothalamic peptide pulses without significant systemic dilution.

2- Feedback control

Negative feedback control

- *Negative feedback exists when the output of a system counteracts a change in input,* maintaining a controlled variable within a narrow range around a desired level, or set point
- Negative feedback ensures that once hormone secretion has been "turned on", it will not continue unabated but will be "turned off" when the appropriate level of free circulating hormone has been achieved.



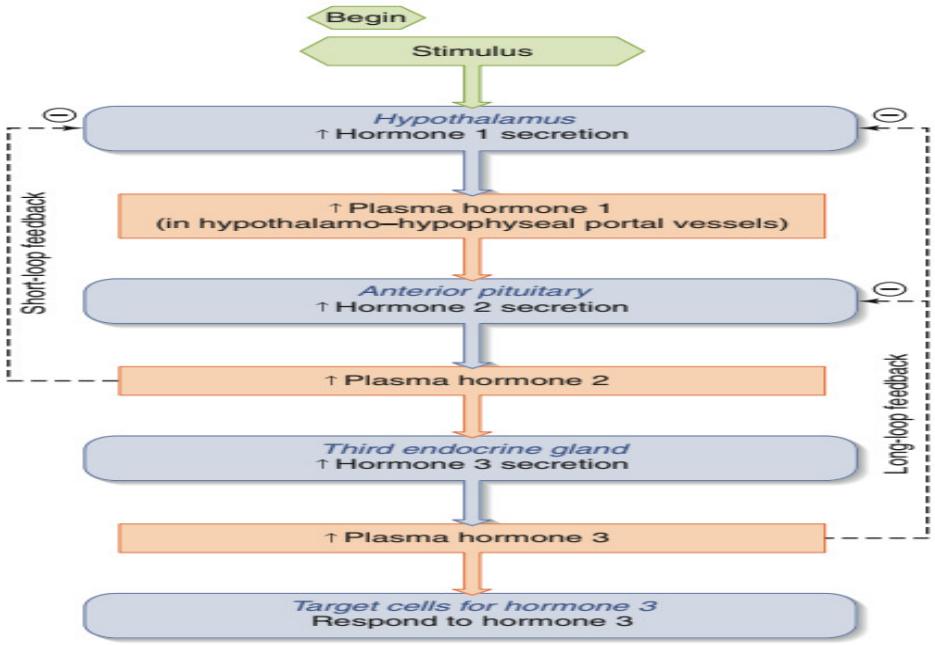
Feedback control could be:

Long-loop negative feedback

The hormone secreted by the third endocrine gland in a sequence exerts -ve feedback effect over the anterior pituitary gland and/ or the hypothalamus

Short-loop negative feedback

Describe the influence of an anterior pituitary gland hormone on the hypothalamus.

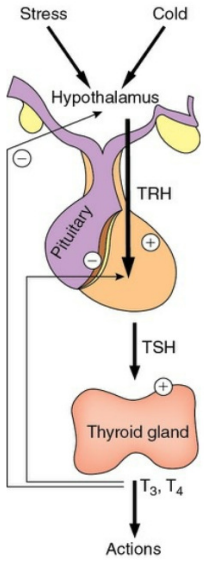


Anterior pituitary hormones

Thyroid-stimulating hormone (TSH)

Synthesis and secretion

TSH-secreting **thyrotrope** cells constitute 5% of the anterior pituitary cells



Action:

TSH is the physiologic regulator of T4 and T3 synthesis and secretion by the thyroid gland. TSH also promotes nucleic acid and protein synthesis in the cells of the thyroid follicles, maintaining their size and functional integrity.

Regulation:

TSH secretion is stimulated by TRH.
TSH is suppressed by thyroid hormones (-ve feedback) and somatostatin.

Adrenocorticotropic hormone (ACTH)

Synthesis and Secretion:

ACTH is synthesized by **corticotrope** cells which are about 20% of the pituitary cells.

ACTH is derived from precursor protein called Proopiomelanocortin (POMC) that also generates β-lipoprotein (its physiologic function in humans has not been established), β-endorphin, and α melanocyte-stimulating hormone (α-MSH).

ACTH contains the α-MSH amino acid sequence, so it has melanocyte-stimulating activity when present in the blood at high concentrations. As a result, patients with **Addison disease** or an **ACTH-secreting tumor**, are often has **hyperpigmentation**.

ACTH secretion is **pulsatile** and exhibits characteristic **circadian rhythm**, peaking t bout 6 am and reaching lowest level bout midnight. Adrenal glucocorticoid secretion, which is driven by ACTH, follows parallel diurnal pattern.

Action:

ACTH stimulate the synthesis and secretion of glucocorticoids, promotes the expression of the genes for various enzymes involved in steroidogesis also also maintains the size and functional integrity of the cells of the adrenal gland (zona fasciculata and zona reticularis).

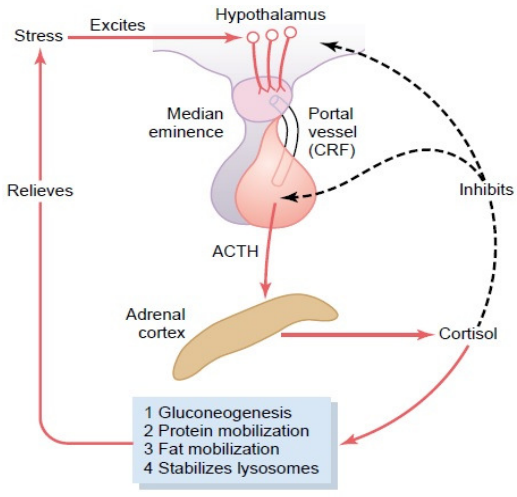


Figure 77–6

Mechanism for regulation of glucocorticoid secretion. ACTH, adrenocorticotropic hormone; CRF, corticotropin-releasing factor.

Regulation:

The predominant stimulator of ACTH synthesis and release is **CRH**.

ACTH levels also increased by physical and psychological stress, exercise, acute illness, and insulin-induced hypoglycemia.

ACTH level decreased by –ve feedback inhibition by high cortisol level.

Gonadotropins

Synthesis and secretion

Gonadotrope cells constitute about 10% anterior pituitary cells. They are 2 hormones LH and FSH.

Its secretion is pulsatile.

Action:

In males:

FSH stimulates spermatogenesis
LH stimulate testosterone secretion

In females:

FSH stimulates early follicular development
LH stimulate final maturation of the ovarian follicle, ovulation
Secretion of estrogen and progesterone.

Regulation:

- Stimulated by GnRH
- Inhibited by -ve feedback inhibition by high level of testosterone, estrogen and progesterone.

Prolactin (PRL)

Synthesis and Secretion:

PRL is synthesized in lactotropes, which constitute about 20% of anterior pituitary cells.

Action:

- ✓ During pregnancy help in development of mammary gland.
- ✓ After labor, it initiates lactogenesis (milk formation) from the mammary gland that are primed by estrogen and progesterone.
  N.B. Lactogenesis is prevented during pregnancy despite the high prolactin level due to high estrogen block prolactin receptor in breast.
- ✓ Prevent ovulation and produce amenorrhea (no menstrual cycle) during lactation (Prevent the action of gonadotropins).

NB: Hyperprolactinemia in woman produce galactorrhea (increase milk secretion) and amenorrhea (no menstrual cycles) and sterility (can't get pregnant).

- ✓ The function in male unsettled, but excess prolactin secreted by tumors causes erectile dysfunction, hypogonadism and infertility.

Regulation:

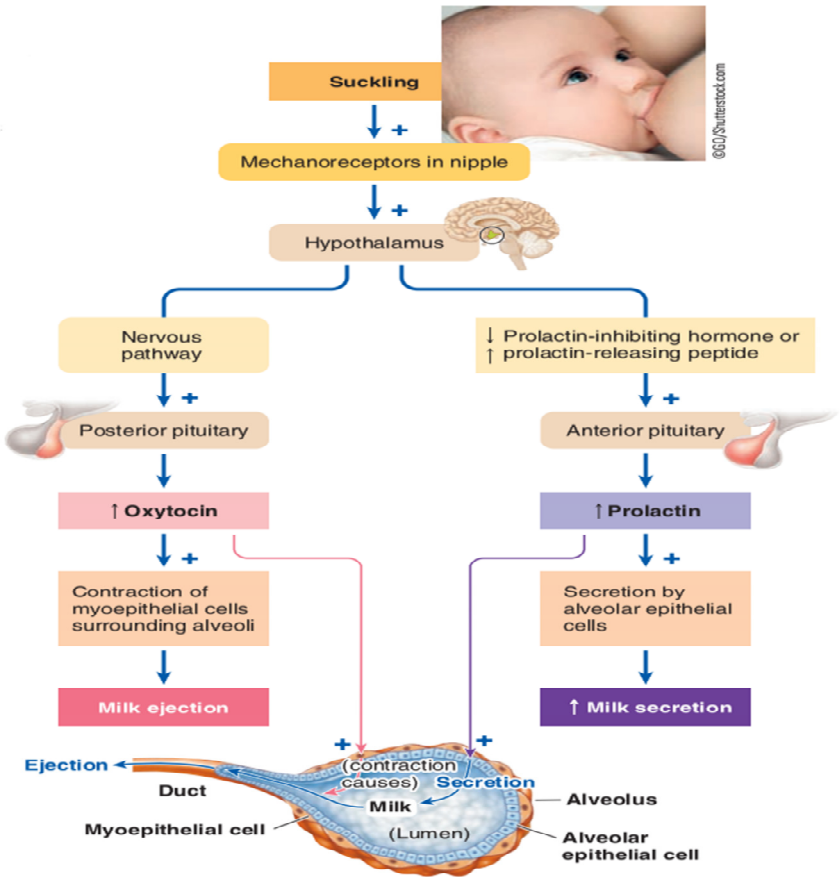
PRL is unique among the pituitary hormones in that the predominant control is inhibitory through PIH (dopamine).
There is a –ve feedback control between prolactin and PIH (prolactin stimulates release of dopamine which in turn inhibit its production)

Stimulators:

- TRH, VIP (vasoactive intestinal peptide)
- After exercise, surgical procedures
- Psychological stress
- Stimulation of nipple
- Sleep (starting after onset of sleep and persist throughout the sleep period)
- Pregnancy (reaching peak at time of parturition)
  NB: After delivery, the plasma conc. falls to non-pregnant level, suckling increase its secretion again, but the magnitude gradually declines after nursing for more than 3 months.
- Dopamine receptor blockers

Inhibitors:

- L-dopa
- Dopamine agonist



SUGGESTED TEXTBOOKS

1. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 17-18, from page 307 to 334
2. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 76, from page 939 to 950
3. Lauralee Sherwood Human Physiology: From Cells to Systems, Ninth edition 2016. CENGAGE, chapter 18, from page 646 to 652